Oudin Coil

Amount of time demo takes: 5-10 minutes

Try this in the classroom!

Lesson's Big Idea

- Power can be transmitted wirelessly.
- Voltage/electricity dissipates as it travels through resistors.

Materials

- Oudin coil (Arbor Scientific or Educational Innovations)
- Fluorescent light bulb(s)
- Anything metal (pop can)
- Extension cord - **Needs electricity**
- Gaff Tape for safety boundary

SAFETY!

- Do not put anything into the tip of the coil except the actual apparatus.
- The coil is not designed for continuous use -- do **10 minutes on, 10 minutes off**.
- If touching the light bulb, do not touch the metal ends (you will get shocked, and you will feel it!). Unplug the Tesla coil when not in use.
- The smaller the light bulb, the faster it will heat up. Warn participants that they may receive a small electric shock near this demo. People with pacemakers or other heart electrical abnormalities should take precautions while around this demo.
- Be sure that all cell phones and electronics have been removed from the vicinity prior to beginning the demo
- Be sure to set boundaries with the participants prior to beginning the demo!

Background Information

- This Tesla coil is rated at 120v 60hz. It effectively 'steps up' the voltage from the wall (110 volts) to many times that: somewhere between 20,000 and 45,000 volts! The output frequency is approximately 500 kHz -- the current output of the spark is about 1 mA.

- How the Tesla coil works:
    - A transformer steps up the ordinary, household voltage to many thousands of volts.The current moves to a **capacitor**, where it builds up until fully charged (like a battery).
    - Once the capacitor sets the current free, the current flows into a spark gap. The gap is effectively a 'switch' - it turns the current 'on and off' which allows the current to flow into the primary copper coil. A magnetic field forms, collapses, and discharges back to the capacitor (over and over and over).
    - Each time this exchange happens a bit of current goes into the second coil, which has a smaller-gauge wire than the first and is coiled up into more 'turns.' The current increases proportionally to the number of turns. The 'bouncing' magnetic field and wireless transfer of current is called **resonant inductive coupling**.
    - Lastly, there is a **second capacitor** at the end of the second coil, which is where the visible action takes place. The capacitor (often spherical or toroidal) discharges into the surroundings, which is what you see!
- Fun fact: the plasma ball demo is actually a low-power cousin of the Tesla coil (it ionizes gases within the ball).

Setup Instructions

1. Insert the metal electrode into the black handle. Plug in.
2. **Needs two demonstrators!**
3. Set out cans, light bulbs, and any other demonstration materials.

Instructional Procedure

1. Set work area boundaries to ensure a safe working area!
2. Press the button to activate. Adjust the knob on the back of the handle to change voltage.
3. In this case, changing voltage will change the arc length. There are many exercises you can do with this apparatus! Here are just a few ideas:
    a. Move the electrode close to something metallic -- an arc should jump between the two.
    b. Set up a bunch of metallic objects in a line about ¼ inch away from each other. Ask students what they think will happen if you shock one end of the chain, then do so..
    c. Put the light bulb on a table -- ask the participants what they think

will happen when you move the electrode along the length of the bulb. Fun fact from Arbor Scientific: even a burned-out fluorescent light tube will glow when the Tesla Coil is held nearby.

d. Do the same thing as in (c.), but have a participant touch your shoulder (they should receive a small shock).

e. Grab onto the electrode **while it is off**, then hold hands with someone. Turn it on -- the other person should be able to reach out and shock people.

Tips & Tricks

- Coming soon!

Assessment Questions

- For part (e.): Why doesn't the person in the middle get shocked?
- For part (b.): Why do the arcs get weaker further down the chain?
- What does a transformer do? A capacitor? How are they related in a Tesla coil?

Careers & Real-World Applications

- Electrical Engineering - Installation as emergency backup light systems.
- Sustainable and Renewable Energies - In combination with a solar panel or wind turbine system to funnel electricity to a single home or system of homes.

Clean Up

Unplug the tesla coil **before** removing the electrode. Pull electrode off (no twisting!). Neatly package everything back into the kit. Let someone know if anything is depleted, missing, or broken.

References

- Arbor Scientific (vendor): http://www.arborsci.com/tesla-coil
- A fairly concise explanation of what happens in the coil: http://www.ehow.com/how-does_4564039_tesla-coil-work.html
- DC TESLA COIL Construction And Applications: https://www.researchgate.net/publication/305955805_DC_TESLA_COIL_Construction_And_Applications

Related Next Generation Science Standards

- K-5
    - 3-PS2 Motion and Stability: Forces and Interactions
    - 4-PS3 Energy
    - 5-PS1 Matter and Its Interactions
- 6-8
    - MS-PS2 Motion and Stability: Forces and Interactions
- 9-12
    - HS-PS2 Motion and Stability: Forces and Interactions
    - HS-PS3 Energy